Interaction Trigger Study

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1 Introduction

In this study, Jon, Nick, and I eye scanned 11,000 minimum bias events to separate good interactions from backgrounds. Using this sample, I tested various possible trigger logics for their efficiency at selected the signal events, and the purity of the final samples they produce. Efficiency is defined as the fraction of events labeled good by scanners which were selected by the trigger. Purity is defined as the fraction of the sample selected by the trigger which was labeled good by scanners.

The trigger logics I considered were $(iDC\&SciLo)|SciHi$, $SciLo$, and $(SciLo\&Prescale)|SciHi$, where iDC refers to the DC interaction trigger, $SciLo$ and $SciHi$ are low and high threshold settings on the scintillation interaction counter which is located behind the target.

2 Scan Method

For this study we (Jon, Nick, Mark) scanned all off runs 12651 and 12652. These runs were minimum bias runs taken with a beam trigger. In total the runs have roughly 11,000 events. The events were placed by the scanners into 8 categories:

1. Events with vertex near target ("good events")
2. Events with vertex in TPC gas ("gas events")
3. Events with vertex upstream of target ("upstream events")
4. Events with only a single beam track ("beam")
5. Events with many tracks that don't for a vertex ("spray")
6. Pile up (multiple beam tracks that overlap in TPC time projection)

	Nick	Mark	Jon	Total
"good" events	86	92	61	236
gas events	8	4	7	19
upstream events	1	10	2	16
beam	3236	3187	2666	9089
spray	109	244	243	596
pile up	59	66	47	172
hard to tell	40	1	15	56
empty	515	449	511	1475
total	4054	4053	3552	11659

Table 1: Summary of hand scan results

7. Hard to tell what was going on

8. Empty (DAQ triggered events)

To train ourselves and ensure that we used similar criteria for classifying events, we scanned roughly 200 events working together at the same terminal. The results of the hand scans are summarized in Table **??**. While there are some differences among the scanners, I don't think they affect the conclusions significantly. For example, Mark was more likely than the other scanners to call an event as arising from an interaction upstream of the target then to call these events spray. Nick was more likely to use the "hard-to-tell" category than either Jon or Mark.

3 SCI Counter Performance

As a first step, I wanted to characterize the performance of the scintillator interaction counter. Figure **??** shows the ADC spectrum of the counter for all events labeled as beam by the scanners. The spectrum is well fit by a Gaussian in the peak region and a Landau in the tail. The peak is at 250 ADC counts and a long Landau tail.

Next, I looked at the ADC spectrum for events labeled interactions by scanners. This spectrum is shown in Figure **??**. By eye, I pick out 1, 2, and 3 mip peaks which I fit to gaussians. There is a possibility that the 1 mip peak is due to interactions in the TPC window. This possibility has not been

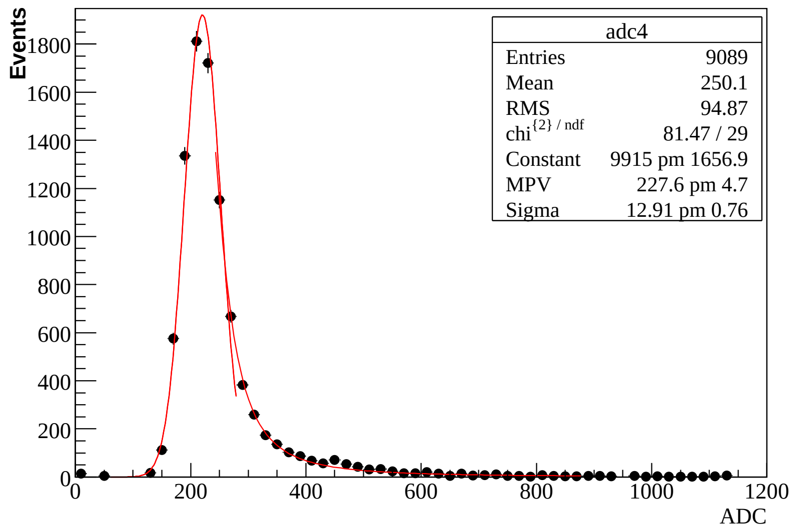

Figure 1: ADC spectrum in SCI counter for beam events. Shown with fit to gaussian at peak and landau in tail.

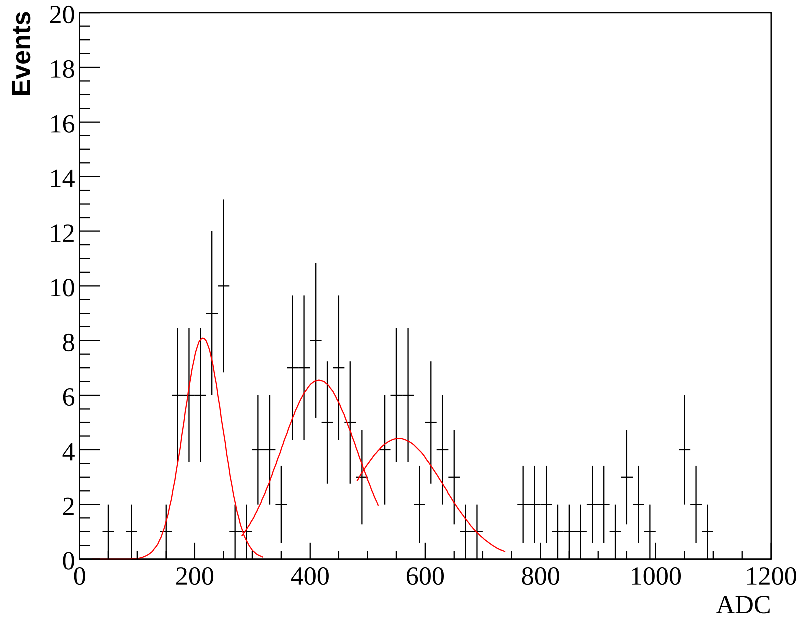

Figure 2: ADC spectra in SCI counter for "good" events. Shown are gaussian fits near the 1, 2, and 3 MIP peaks. The last bin in the ADC spectrum (near ADC 1100, >5 MIP) is off the top scale of the plot.

investigated further. Note, that most interactions appear in the overflow bin of the ADC spectrum and do not show up in the plot. Figure **??** shows the relation between the number of mips and the ADC counts registered by the counter.

For the logic $(iDC\&SciLo)|SciHi$ it is possible to achieve 50% efficiency and 50% purity with the choice of SciLo at 200 ADC counts, and SciHi at 750 counts. Using the trigger definition, the trigger efficiency as a function of number of tracks in the TPC is plotted in Fig. **??**. The efficiency is now quite high for events with 4 or more tracks, but is still very low for 2 track events, and is roughly 50% for 3 track events.

However, this trigger logic does not address the inefficiency of the iDC trigger for low multiplicity tracks where one particle is bent by the JGG field and does not reach the DC counter. Of course, the thresholds for the iDC trigger are now lower so this needs to be looked at again to see what the 2

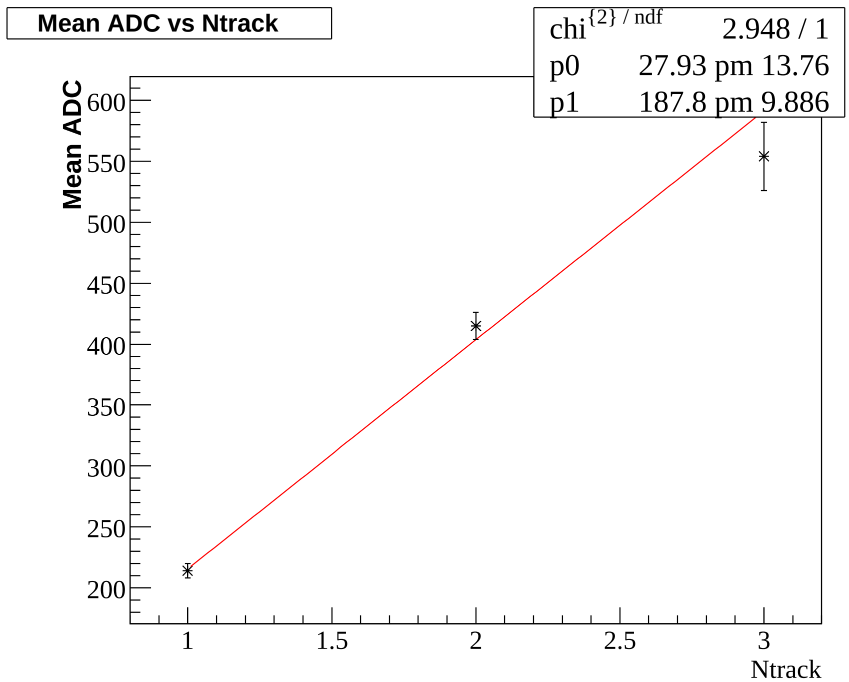

Figure 3: Correspondence between number of MIPs and ADC value for low number of MIPS.

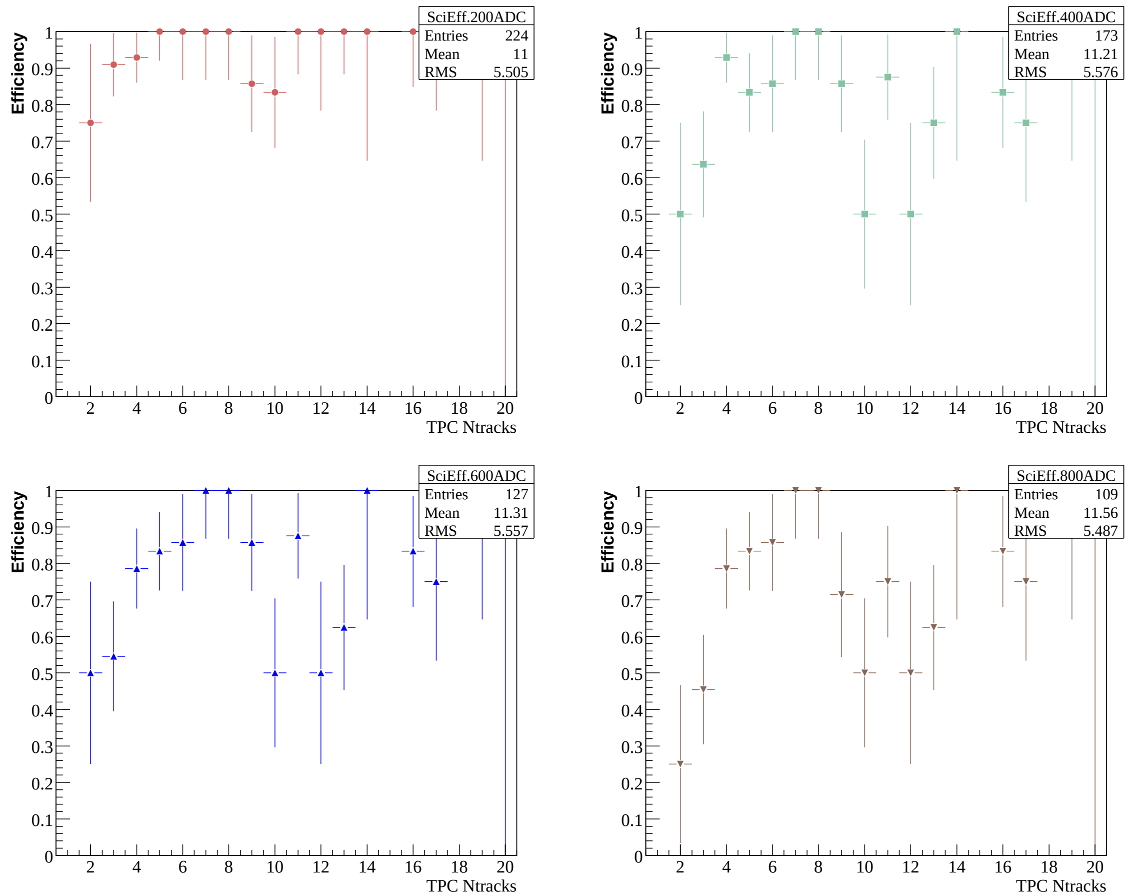

Figure 4: Efficiency of SCI counter as function of number of TPC reconstructed tracks. Four cut thresholds in SCI ADC are applied, 200 (top left), 400 (top right), 600 (bottom left), and 800 (bottom right) counts.

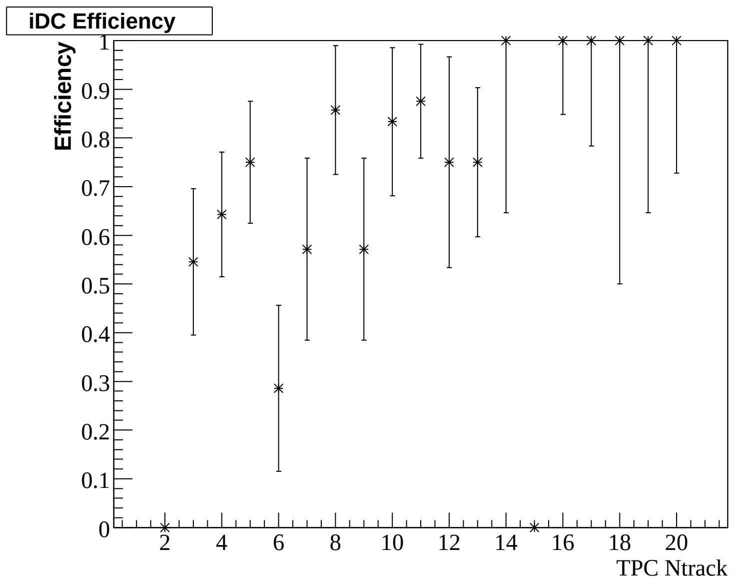

Figure 5: DC interaction trigger efficiency as function of number of TPC reconstructed tracks.

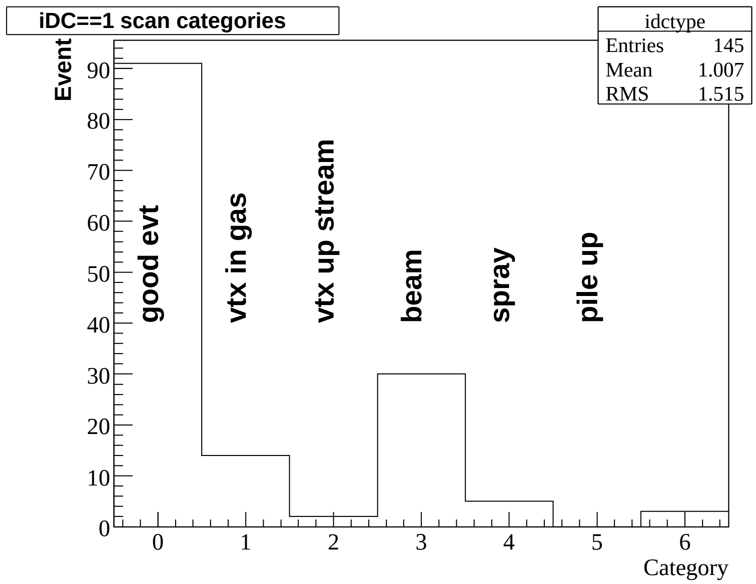

Figure 6: Scan categories for events with iDC present. Of 145 events with iDC present, 91 were considered “good” by scanners giving a purity of 63%.

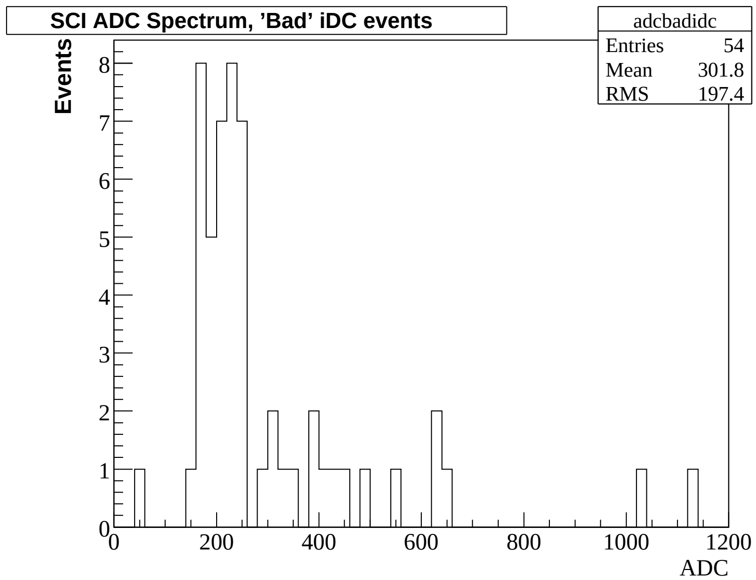

Figure 7: ADC spectrum in SCI counter for events labeled 'bad' by scanner where iDC fired. A cut at ADC=300 removes 38 of the 54 (70%) of the remaining background in the iDC sample.

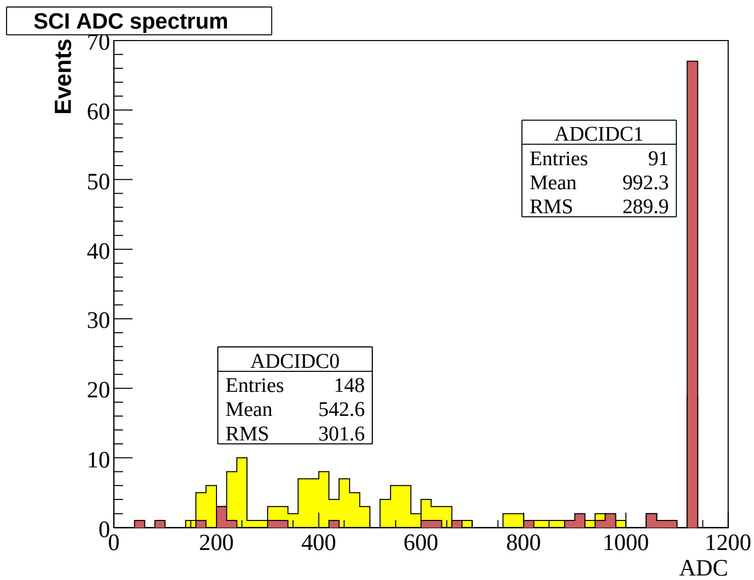

Figure 8: ADC spectrum in SCI counter for "good" events. Dark red histogram are events with iDC on, light yellow histogram are events with iDC off.

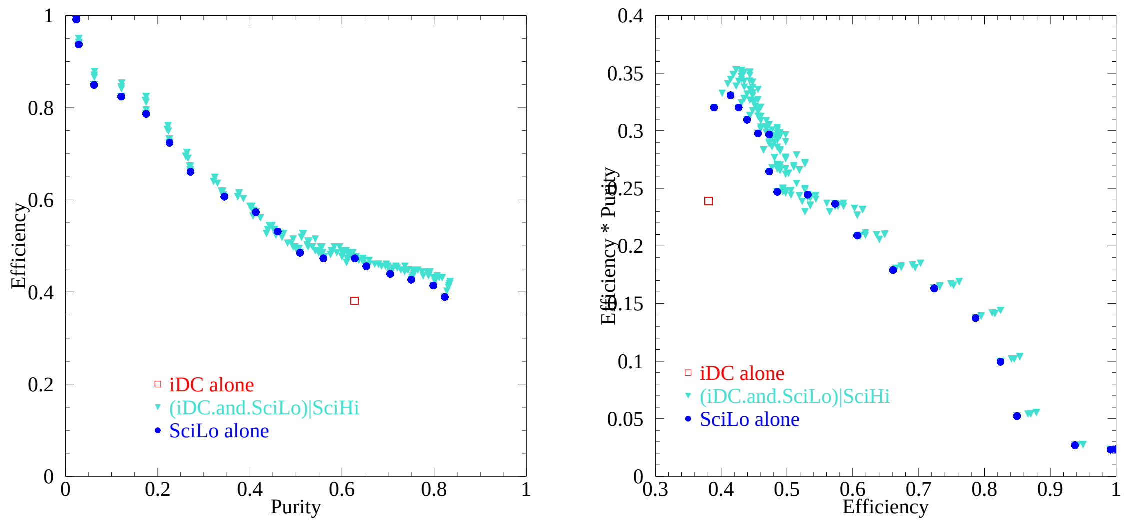

Figure 9: Left: Trigger efficiency vs. sample purity for various trigger logics and thresholds. Efficiency is defined as the fraction of the events labeled "good" by scanners which are accepted. Purity is the fraction of events in the selected sample which were labeled "good" by scanners. The open red square is the iDC trigger alone, the solid blue circles is the SciLo trigger alone, and the light blue triangles are for the logic $(iDC\&SciLo)|SciHi$. The $SciLo$ and $SciHi$ thresholds scanned between 0 and 1000 ADC counts. Right: The product of efficiency and purity as a function of efficiency for the same trigger definitions.

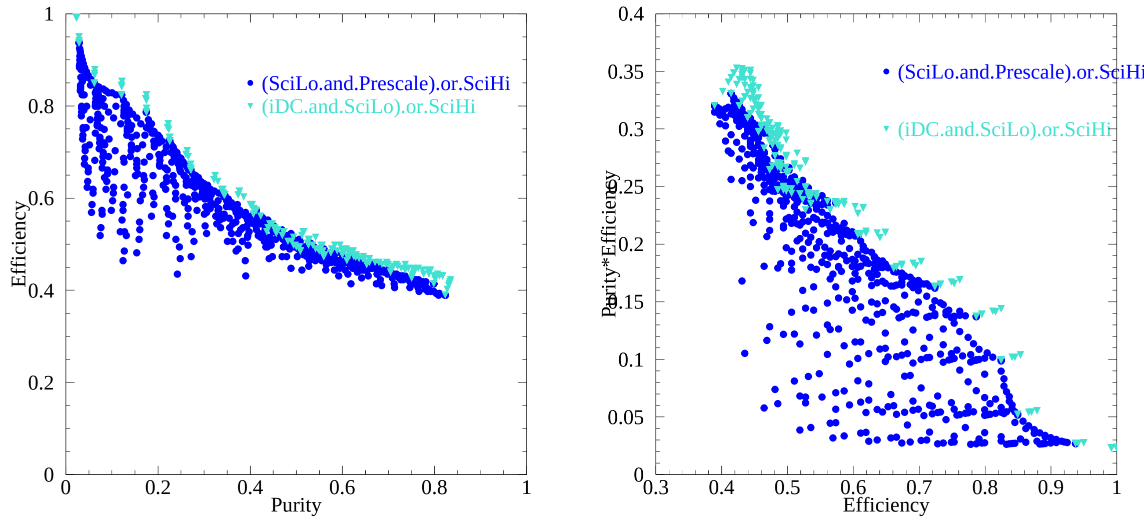

Figure 10: Left: Trigger efficiency vs. sample purity for various trigger logics and thresholds. Efficiency is defined as the fraction of the events labeled "good" by scanners which are accepted. Purity is the fraction of events in the selected sample which were labeled "good" by scanners. The solid blue circles are for the logic $(SciLo\&Prescale)|SciHi$. The light blue triangles are for the logic $(iDC\&SciLo)|SciHi$. Each point represents a different choice of prescale and threshold settings. Right: The product of efficiency and purity as a function of efficiency for the same trigger definitions.

track efficiency is now...

I tried looking at the possibility of using the logic $(SciLo\&Prescale)|SciHi$ for the trigger. Trying all combinations of presacle values, SciLo, and SciHi thresholds I found that this trigger logic performs comparably, but slightly worse, to the $(iDC\&SciLo)|SciHi$ logic. Using this logic, it is possible to achieve 50% purity and 50% efficiency with a prescale of 0.4, SciLo threshold of 550 ADC counts, and a SciHi threshold of 750 ADC counts.

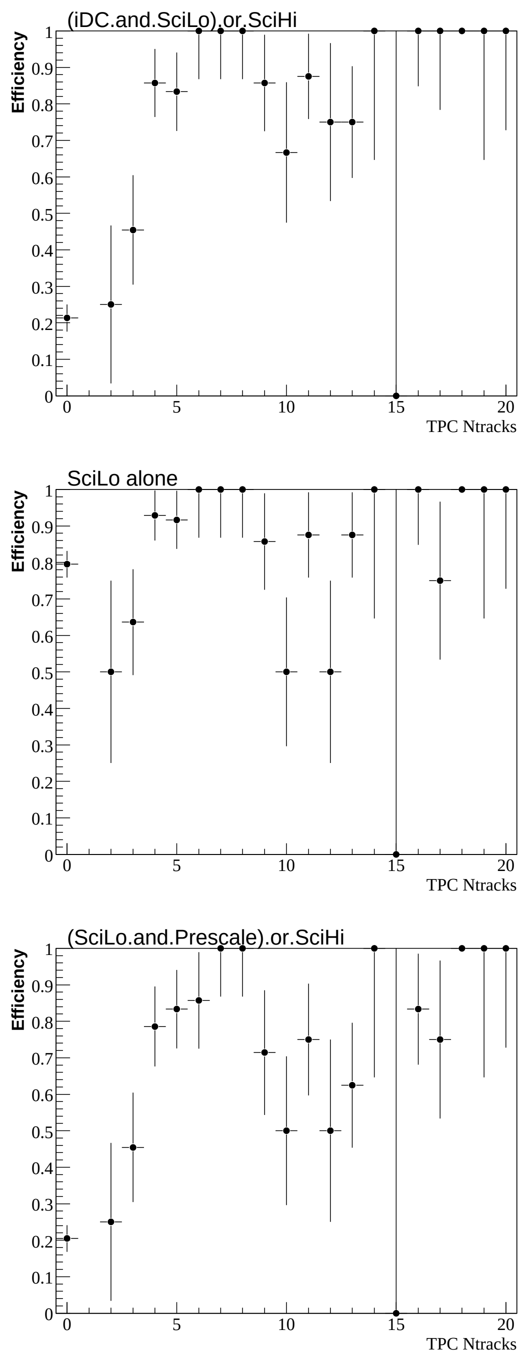

Figure 11: Trigger efficiency vs. number of tracks for three trigger schemes. Top is for the logic $(iDC\&SciLo)|SciHi$, center, is for $SciLo$, and bottom is for $(SciLo\&Prescale)|SciHi$. In each case the thresholds were optimized to achieve and overall efficiency of 50% and purity of 50%.

4 Conclusions

In this report I have looked at three possible trigger schemes
[**A**] (iDC & SciLo) | SciHi,
[**B**] SciLo,
[**C**] (SciLo & Prescale) | SciHi,
and tried to optimize each for efficiency and purity. Here are my conclusions:

1. All three trigger schemes I've presented behave similarly from standpoint of overall efficiency and purity
2. Overall, [**A**] and [**B**] out perform [**C**].
3. Overall, [**A**] slightly out performs [**B**].
4. At low track multiplicities, [**B**] slightly out performs [**A**].
5. I believe the relative simplicity of [**B**] makes it preferable to [**A**].

To make a final decision, I would like to see runs taken with the $(iDC\&SciLo)|SciHi$ trigger and the $SciLo$ trigger. Thresholds should be set at $SciLo = 200$ ADC$\simeq$ 1 mip) and $SciHi = 750$ ADC$\simeq$ 3.5 mip counts in the first case, and $SciLo = 600$ ADC$\simeq$ 3 mip. Assuming the relative qualities of the triggered samples is comparable, I would prefer [**B**].